ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES
CORPS OF ENGINEERS
UNITED STATES ARMY

Report 1304

EVALUATION OF A PROTOTYPE PORTABLE INCINERATOR (22-MAN BARRACKS UNIT) FOR THE DISPOSAL OF HUMAN WASTES, GARBAGE, AND REFUSE

Project 8-71-04-003

11 June 1953

Submitted to

THE CHIEF OF ENGINEERS, U. S. ARMY

by

The Commanding Officer
Engineer Research and Development Laboratories
Corps of Engineers, United States Army

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ABSTRACT

This report covers the experimental tests conducted in the evaluation of a prototype portable incinerator (22-man barracks unit) for the disposal of human wastes, garbage, and rubbish. The unit was designed and fabricated by the John B. Pierce Foundation, Raritan, New Jersey, under Contract DA-44-009 eng-681. After evaluation by the contractor, the unit was shipped to ERDL for final evaluation by the Sanitary Engineering Branch.

The report concludes that:

1. The prototype portable incinerator for a 22-man barracks unit is capable of reducing human wastes, garbage, and rubbish to a fine ash.

2. The waste-to-fuel ratios averaged 1.49 lb of human waste per pound of fuel, 1.47 lb of garbage per pound of fuel, and 0.37 lb of rubbish per pound of fuel for the ERDL tests.

3. Of the total fuel consumption, 22 percent is used to destroy odors, and 78 percent for incineration proper.

4. Because the water content of human wastes and garbage is very high, the incinerator operates primarily as an evaporator until all water is driven off.

5. The efficiency of the incinerator is further reduced when using combustible materials because of the lack of sufficient air provided to the combustion chamber.

6. Operation demands extreme attention and caution to assure adequate incineration and to avoid injury to the operators.

7. The unit tested does not provide an economical method of waste disposal and there is no basis for believing that modification of the item would materially improve its performance.

8. For the application under consideration in this study, incineration is not an acceptable method of disposal of human wastes and garbage, and only improvised facilities are required for burning combustible rubbish.

9. Requirements and acceptable methods for field waste disposal, promulgated by competent authority, are not a matter of record.

The report recommends that:

1. The prototype portable incinerator for a 22-man barracks unit, developed under Project 8-71-04-003 and described herein, not be considered for use in the disposal of wastes, garbage, or rubbish in the field.

2. Action be initiated to review and study the entire subject of field waste disposal to provide administrative and technical guidance to further work in this basic field.

EVALUATION OF A PROTOTYPE PORTABLE INCINERATOR (22-MAN BARRACKS UNIT) FOR THE DISPOSAL OF HUMAN WASTES, GARBAGE, AND RUBBISH

I. INTRODUCTION

1. Subject. Because it is difficult to dispose of human wastes and garbage in continuous frost areas, this problem led to the belief that incineration might be used advantageously at military installations in polar regions. To investigate the possibility of incineration more fully, the Engineer Research and Development Laboratories, Fort Belvoir, Virginia, awarded Contract DA-44-009 eng-691 to the John B. Pierce Foundation, Raritan, New Jersey, for designing and fabricating a unit to service a personnel group of 22 men. After construction and evaluation by the contractor, the incinerator was shipped to ERDL for final evaluation by the Sanitary Engineering Branch. This report covers all of the experimental tests conducted in the evaluation of the prototype unit.

Authority for this investigation is contained in Project 8-71-04-003, "Utilities, Packaged for Prefabricated Buildings." A copy of the project card is included as Appendix A.

2. Background and Previous Investigation. The disposal of human wastes, garbage, and rubbish at permanent or semipermanent military installations in areas of continuous permafrost is a problem affecting the health of the command. A fully satisfactory method of disposal has not been presented, although several methods have been used or proposed. Among these methods, listed with pertinent comments, are the following:

a. Storage in Tanks. Storage of waste in tanks does not appear feasible because of the large capacity required, even when considering a medium-sized installation.

b. Chemical Destruction. Too large a quantity of chemicals is required. Storage tanks and piping will corrode if metallic containers are used.

c. Storage in Dumps with Repellants. Several manufacturers, encouraged by the Department of the Interior and the Department of Agriculture, are conducting research of chemical repellants capable of preventing bacteriological action in organic matter as well as preventing rodents and wild life from attacking waste dumps. Currently, the effective repellants are poisonous and expensive.

d. Dumping at Sea. This method has been tested and found to be time-consuming as well as expensive. Also there were indications that some of the material found its way back to installations.

e. Grinding-Oxidizing Toilet Unit. A method has been devised for the disposal of human wastes which involves grinding and then recirculating this material in a constant volume of water. The wastes are oxidized by the admission of air into a storage tank. Eventually, the liquor must be disposed of and current data are inconclusive.

f. Sanitary Landfill. Tests conducted at Fort Churchill, Canada, by the Corps of Engineers showed that bagged human waste can be kept outdoors in a frozen state for a winter's duration without imparting odor to the area. The bacteria are dormant and there is no putrefaction. Burial of waste during the summer is feasible.

g. Incineration. Very little data are available relative to the use of incineration for disposing of waste in polar regions. It is the object of this report to evaluate a prototype portable incinerator designed for arctic use.

3. Personnel. The negotiation, award, and management of the contract leading to the development of the prototype portable incinerator were carried out by Hyman Grupp and Ignatius E. Campagna of the Prefabricated Buildings Branch, EPDL, Fort Belvoir, Virginia. Testing of the unit was accomplished by M/Sgt. Joseph Kennedy, Cpl. M. Knusky, Pfc. R. M. Jahrling, and Pfc. R. J. Rathbun, under the supervision of Andrew Gutierrez, Project Engineer, and D. C. Lindsten, Chief, Waste Disposal Section. This work was directed by Harry M. Lowe, Jr., Chief, Sanitary Engineering Branch, and Lt. Col. C. P. Joyce, Chief, Military Engineering Department.

II. INVESTIGATION

4. Description of the Prototype Portable Incinerator. The prototype portable incinerator is skid-mounted, but it is not designed for towing as a sled. Excluding the stack, which is demountable for shipment, the unit is 7 ft and 9 in. long, 2 ft and 8½ in. wide, and 3 ft and 1½ in. high. See Fig. 1. The total weight of the unit is 1036 lb.

The unit consists of two separate sections. The rear section is the burner compartment which contains a 15 gal fuel tank, operating burners, and spare burners, and the front section is the combustion chamber. Both the burner compartment cover and the

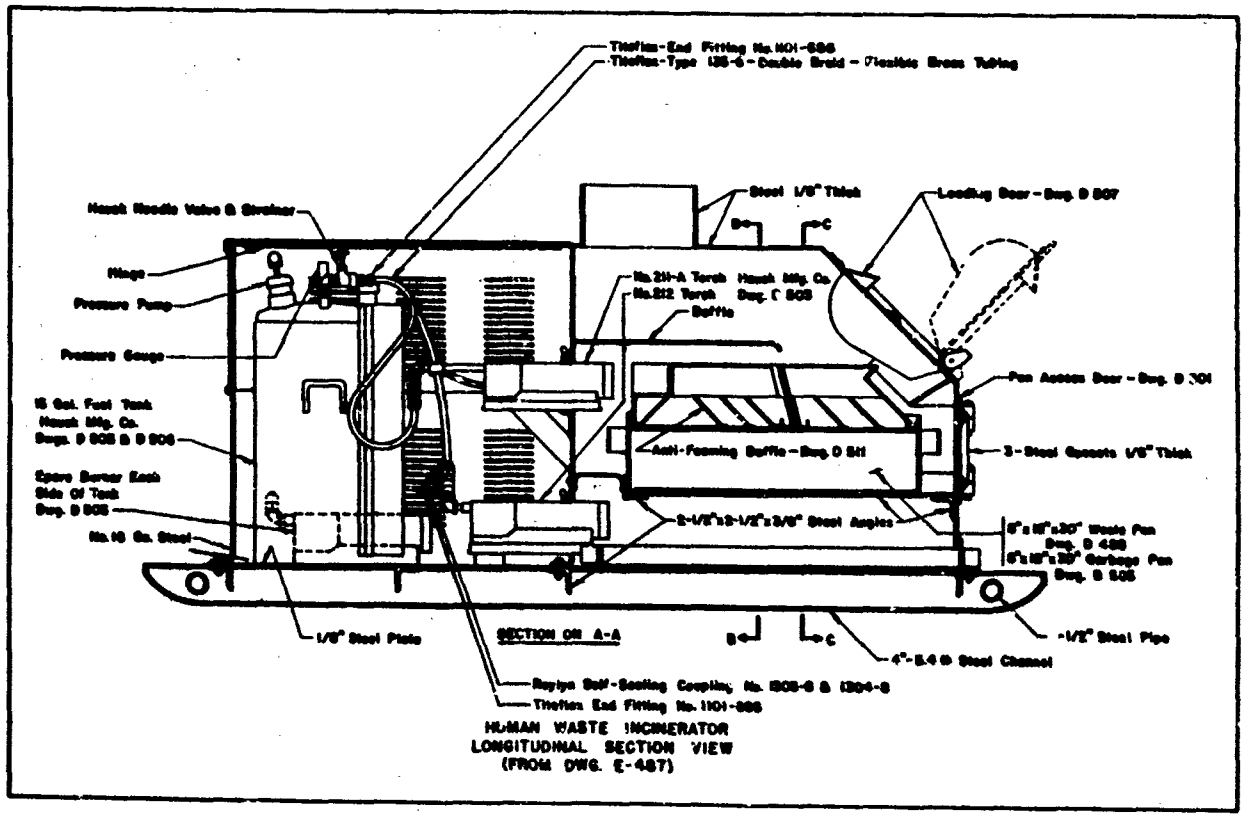

Fig. 1. Cross section of the Prototype Portable Incinerator for a 22-man barracks unit.

combustion chamber shell are bolted to the frame and can be removed separately. When a full load of human waste is to be incinerated, a foam control grid can be placed on top of the waste pan. When in use, the two burners rest on support brackets and extend into the combustion chamber. The fuel line connections between the burners and the fuel tank, made of flexible metal hose, are equipped with self-sealing, quick-to-disconnect couplings. The burners are self-energized and electric power is not required for ignition or operation. The fuel tank is mounted behind the burners. Rotary arm-type catches hold the tank in place. A quarter-turn counter clockwise allows the tank to be freed for removal from the incinerator. A shield in front of the tank prevents the combustion chamber radiation from overheating the fuel. The spare burners are held in the compartment by straps on the bottom of the compartment.

There are two waste pans -- one with a solid bottom to incinerate human waste and garbage, and the other with a perforated bottom to incinerate rubbish. The waste pans are put in place through the front door; they slide into the combustion chamber on tracks fastened to one side of the incinerator wall. On the bottom of the combustion chamber, there is a drip pan to collect the overflow from the waste pan containing the charge. Holes were tapped in the side of the incinerator shell and in the stack to connect the thermocouples making it possible to read the temperatures in the combustion chamber, waste pan, and incinerator stack by means of a Micromax automatic potentiometer. A diagram of the unit is presented in Fig. 1; photographs of the unit are presented in Figs. 2-6.

5. Evaluation by the John B. Pierce Foundation. With little background material or data to work with, the John B. Pierce Foundation arbitrarily chose 2 hr as the maximum operating time per incinerator charge and initiated a program of basic studies to obtain the required information concerning waste composition. This program also included a study of the methods of heat application. The foundation reported the nature of human wastes for a 22 man barracks which is presented in Table I.

Table I. Nature of Human Wastes for a 22-Man Barracks Unit

Types of Waste	Weight (lb per day)	Volume (gal per day)	Water Content (%)
Fecal Matter	7.26	---	75.0 to 80.0
Urine	48.4 to 87.1	5.80 to 10.6	95.0 to 96.0
Combined Wastes	55.9 to 94.6	6.70 to 11.3	93.3 to 94.4

Note: For Arctic use, a 40 percent overloading factor would be advisable.

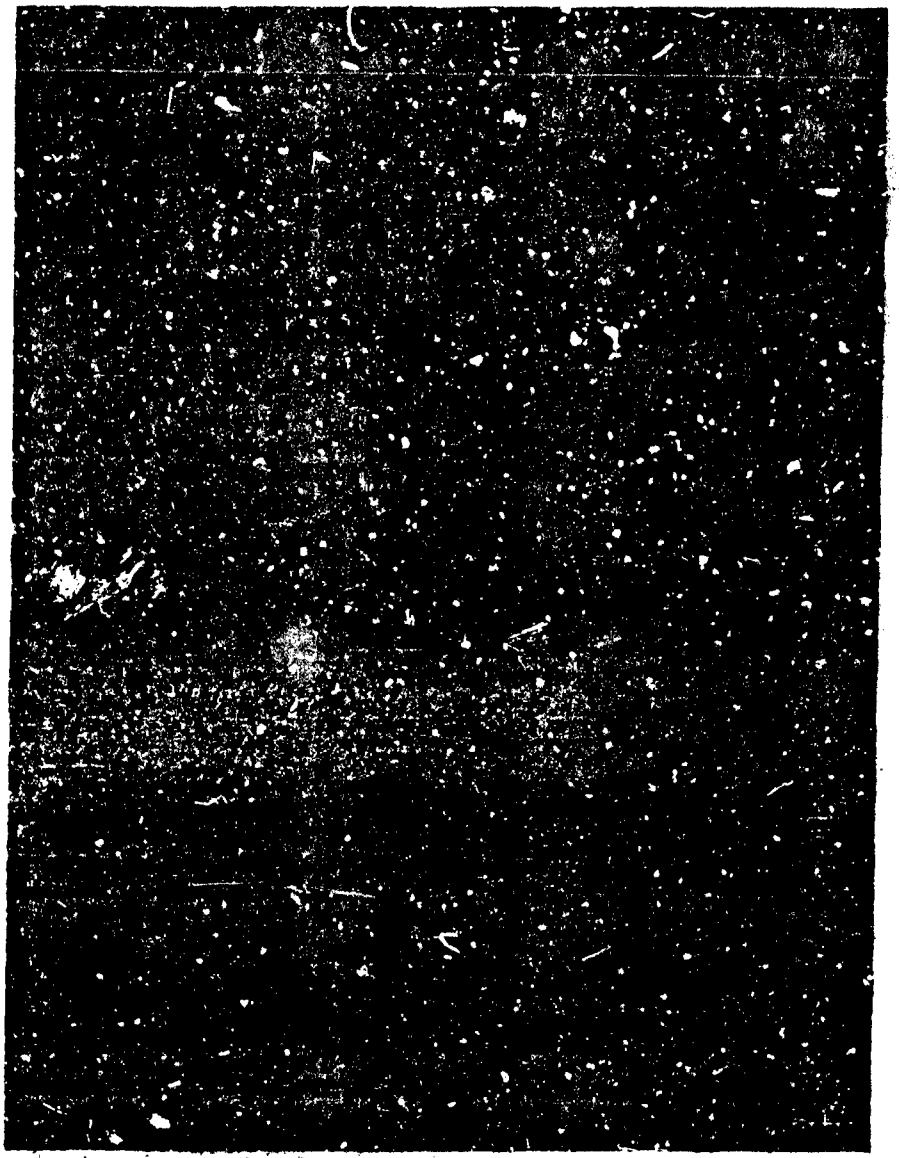

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Fig. 2. Prototype Portable Incinerator for a 22-man unit as seen from the front.

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Fig. 3. The burner compartment of the Prototype Portable Incinerator for a 22-man barracks unit as seen from one side. Note the fuel tank and the upper operating compartment.

Fig. 4. Prototype Portable Incinerator for a 22-man barracks unit as seen from one side.

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Fig. 5. Appurtenances of the Prototype Portable Incinerator for a 22-man barracks unit. Note the drip pan, solid waste pan, perforated waste pan, and the foam conical grid.

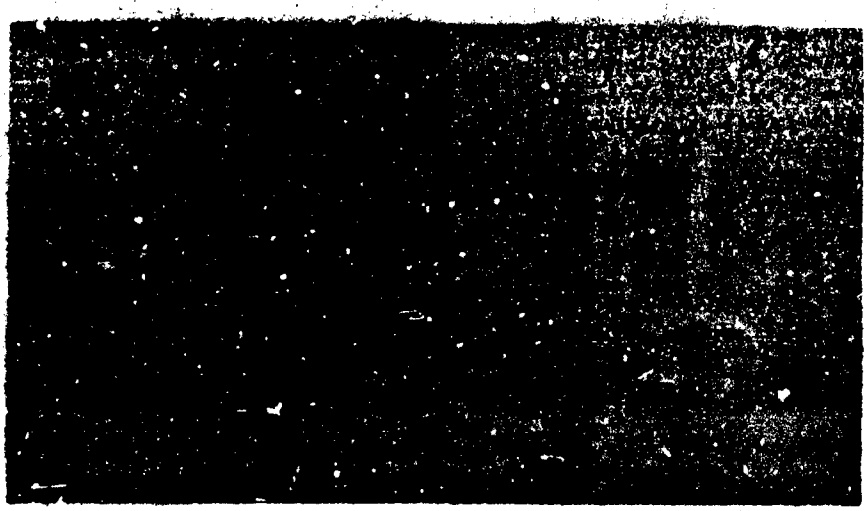

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Fig. 6. The Micromax automatic potentiometer and appurtenances.

A full size experimental incinerator unit was constructed. At the same time, research was initiated to study methods of odor destruction in connection with direct incineration. Next, the prototype portable incinerator was designed around the basic information resulting from previous stages of the program and a model was fabricated to conform to the following specifications:

a. Heat input of at least 300,000 Btu per hour.

b. Air supply of at least 1000 cfm free air.

c. Capable of burning gasoline or diesel oil.

d. Not less than 12 in. diam stack provided with manually operated damper.

e. Water drip pan and element door provided.

f. Top loaded with a 16 x 17 in. opening 24 in. from the ground.

g. A 5½ cu ft capacity capable of treating 100 lb of human waste per charge.

h. To operate free from visible stack effluents.

Upon fabricating the incinerator, it was submitted to a series of tests. The results of these tests are as follows:

a. Ninety pounds of human waste were incinerated in a single charging within a period of 2 hr.

b. The efficiency of the unit, expressed as the ratio of waste incinerated to fuel burned, averaged 2.6 lb of waste per pound of fuel, or equivalent to 1.7 lb of fuel per man per day.

c. Garbage was incinerated to a fine ash and waste-to-fuel ratios were lower than for human wastes (1.86 lb of garbage per pound of fuel burned).

6. Final Evaluation by the Sanitary Engineering Branch. Upon completion of the evaluation by the contractor, the prototype portable incinerator was shipped to the Sanitary Engineering Branch, NMCL, for final evaluation. Tests were conducted using tap water, bucket human waste, privy human waste, raw sewage plant sludge, mess hall garbage, and rubbish. The results of these tests are as follows:

a. Tap Water. Tap water was used in two tests. Ninety-nine pounds of tap water were evaporated in the first test using

diesel oil as fuel. In the second test, the same quantity of water was evaporated, but gasoline was used as fuel. The fuel tank and the fuel were weighed before and after incineration to obtain the quantity of fuel consumed. The fuel tank pressure was raised to 50 psi and thus maintained throughout the test using the hand pump provided. The torch nozzles were cleaned, using the wire cleaning tools, as a precaution against carbon or lead accumulation clogging the nozzle openings. The torches were preheated to initiate vaporizing action. A small amount of fuel was allowed to pass the needle valve and to accumulate in the burner pans; afterwards, the valves were closed again and the fuel was ignited. Vaporization began as the torches were heated. When this action gained intensity, the needle valves were opened slowly and more fuel was fed to the burners. Maximum opening of the valves was established at a point where a sustained roar was obtained and a slightly bluish flame was produced. Temperatures at the combustion chamber on top of the waste pan and in the stack were read simultaneously every 5 min by means of a Micromax automatic potentiometer. The average temperatures at the combustion chamber were 1048 F and 1043 F for test runs 1 and 2 respectively. The waste-to-fuel ratios, rate of incineration, and rate of fuel consumption for test runs 1 and 2 are as follows:

Waste-to-fuel ratio:	2.90 lb per lb and 2.70 lb per lb
Rate of incineration:	91.6 lb per hr and 91.6 lb per hr
Rate of fuel consumption:	31.4 lb per hr and 34.0 lb per hr
Incineration time:	1 hr and 5 min

b. Bucket Human Waste. A bucket sample of human waste, containing feces, urine, and toilet paper, was collected and submitted to test. The material weighed 39 lb. Temperatures were read at 5 min intervals and diesel oil was used as fuel. The combustion chamber temperature averaged 537 F; the temperature on top of the waste pan was 856 F and in the stack, 842 F. The tank fuel pressure was maintained at 50 psi throughout the test. The waste-to-fuel ratio was very low; 1 lb of waste was incinerated per 1 lb of fuel consumed. The rate of waste incineration was 36.1 lb per hr and the fuel consumption rate was 35.9 lb per hr. The ash content was 1.3 percent which indicated complete incineration. One hour and 5 min were required to incinerate the batch. The burners did not appear to operate at peak efficiency. The color of the flame was unsatisfactory and burner adjustment failed to improve the performance.

c. Privy Human Waste. One hundred pounds of material were collected from a privy in daily use. The same procedure was followed as in the previous tests. Fuel pressure was maintained at 50 psi. The temperatures were read every 5 min and recorded. The combustion chamber temperature reached a maximum level of 1321 F and did not vary significantly during the test. The temperature on top

of the charged pan and the stack reached a level of approximately 1085 F and 907 F, respectively, and remained at this level for the duration of the test. Complete incineration was accomplished after 3 hr and 10 min of incineration. No odor was noticed at the incinerator, however, slight odor was noticed in the general area. The waste-to-fuel ratio was 2.18 lb of waste per pound of fuel and the ash content was 2.5 percent. Incineration required more time than any of the preceding tests -- 3 hr and 10 min.

d. Raw Sewage Plant Sludge. A test was run on raw sludge from the Fort Belvoir sewage plant primary sedimentation plant. Gasoline was used as the firing fuel for this test and the pressure was maintained at 50 psi. The known precautions in regard to keeping the burners in operation were practiced and good combustion was attained. One hour and 40 min were required to incinerate 95 lb of raw sludge; the waste-to-fuel ratio was 1.30 lb of waste per pound of fuel and the ash content was 2.1 percent.

e. Mess Hall Garbage. Two tests were performed to incinerate mess hall garbage; gasoline was used for one test and diesel oil was used for the other test. The waste-to-fuel ratios were 1.35 lb of garbage per pound of fuel and 1.6 lb of garbage per pound of fuel. The fuel rates were 29.7 lb for the first test and 26.8 lb for the other test; incineration times were 2 hr and 10 min and 1 hr and 15 min. Good incineration was accomplished. The first test showed an ash content of 2.3 percent; this indicates that, other things being equal, the greater the percentage of solids in the batch to be incinerated, the longer the time required for incineration.

f. Rubbish. Two tests were performed on rubbish obtained from office waste baskets. Gasoline was the fuel used in one test and diesel oil was used in the other test. Although gasoline is slightly higher in Btu value than diesel oil, the waste-to-fuel ratio was lower when gasoline was used as the firing fuel. In both cases the waste-to-fuel ratios were low: 0.34 lb of waste per pound of gasoline and 0.40 lb of waste per pound of diesel oil. The fuel rates were 51.8 and 47.3 lb per hr and the incineration rates were 17.5 and 20.5 lb per hr for gasoline and diesel oil respectively. The incineration time was 1 hr and 17 min for gasoline and 1 hr and 10 min for diesel oil. The lack of sufficient air in the combustion chamber retarded the incineration of the combustible matter and, therefore, decreased the efficiency of the incinerator to a low value.

g. Summary. Complete results of the test conducted at the Sanitary Engineering Branch are presented in Table II; test data sheets are included as Appendix B.

Table II. Evaluation of a Portable (22-Man Barracks Unit) Incinerator for the Disposal of Human Wastes, Garbage, and Rubbish

Test No.	Material Charged	Fuel Used	No. of Burners	Time of Test (hr)(min)	Amount of Fuel Consumed (lb)	Fuel Consumption Rate (lb per hr)	Weight of Material Incinerated (lb)	Incineration rate (lb per hr)	Avg Temp (°F) Combustion Chamber	Top of Fan	Stack	Waste-to-Fuel Ratio (lb material to lb fuel)	Fuel Tank Pressure (psi)	Ash Content (%)	Weather	Air Intake Ports	Remarks
1	tap water	Diesel oil	2	1 5	34.00	31.4	99.0	91.6	1063	1083	1042	2.90	50	--	clear, no wind	½ open	--
2	tap water	gasoline	2	1 5	36.75	34.0	99.0	91.6	1043	773	815	2.70	50	--	clear, sunny	½ open	Combustion chamber was erratic.
3	rubbish	Diesel oil	2	1 10	55.00	47.3	84.0	80.5	1161	1345	1269	0.40	50	4.1	cloudy, no wind	wide open	Stirred rubbish to help incineration.
4	"bucket" human waste	Diesel oil	2	1 5	38.75	35.9	39.0	36.1	537	856	842	1.00	50	1.3	drizzling rain	½ open	--
5	mess hall garbage	Diesel oil	2	1 15	33.50	26.8	55.0	44.0	1042	1167	1273	1.60	50	2.3	windy, cool cloudy, rainy	½ open	Smoky stack.
6	mess hall garbage	gasoline	2	2 10	64.50	29.7	87.0	40.1	1886	1218	1097	1.35	50	8.1	sunny, warm	½ open	Top burner was cut off ½ way through test.
7	rubbish	gasoline	2	1 17	66.50	51.8	22.5	17.5	1743	1727	1655	0.34	50	6.6	cloudy, cool	wide open	Stirred rubbish to help incineration.
8	new sewage plant sludge	gasoline	2	1 40	73.00	44.0	95.0	57.2	1421	1150	1172	1.30	50	2.1	clear, sunny	½ open	Baffles used, no foaming.
9	privy human waste	Diesel oil	2	3 10	46.00	14.5	100.0	31.6	1321	1085	907	2.18	50	2.5	clear, warm	wide open	Baffles used, no foaming.

III. DISCUSSION

7. Discussion. The evaluation tests of the prototype portable incinerator were made in the temperate zone rather than in a polar region where the unit was intended to be used. Nevertheless, the results are significant. Examination of the data shows low average waste-to-fuel ratios. These ratios are 1.49 lb of human waste per pound of fuel, 1.47 lb of garbage per pound of fuel, and 0.37 lb of rubbish per pound of fuel. The extremely low value for rubbish is attributed to insufficient air for combustion. The incinerator was designed to treat wastes containing from 65 to 96 percent moisture and from 4 to 25 percent combustibles. Rubbish containing approximately 70 percent combustibles requires more air for incineration. For human wastes, garbage, and materials of high moisture content, the process is essentially one of evaporation, requiring much heat and a small quantity of air in excess of that required for the combustion of liquid fuel. The low waste-to-fuel ratios of all materials would be expected to be even lower in polar regions where the heat losses would be materially increased. This means that a very large quantity of fuel would have to be transported to the field per unit of wastes to be incinerated. If the efficiency was unity, it would be just as practical to transport the wastes to a remote disposal point as to handle the fuel from the Zone of the Interior to the field.

Odor control during the tests generally was satisfactory. The upper burner, primarily for odor control, performed effectively. In only one test, using privy human wastes, was odor slightly noticed in the area. If odor control was unnecessary, the upper burner could be turned off resulting in a 22 percent saving of fuel.

When incinerating human wastes, foaming proved to be a problem during the evaluation tests by the John B. Pierce Foundation. Foaming was not experienced during the NCEL tests, with or without the foaming control grid. The behavior difference may be attributed to a difference in composition of the test materials.

Safety in the starting and operation of the incinerator proved to be an important consideration. Gasoline or diesel oil at 50 psi pressure burning at a temperature level of 1400 F, or more, was treated with precaution. Standard safety precautions in the handling of gasoline or diesel oil must be observed at all times to prevent explosions or fires which might result in property damage or injury to the operators.

Loading, carbonizing, or clogging of the outlet orifices of the burner occurred frequently. The orifices were cleared using a wire tool provided with the unit. The unit was not operated over a long enough period to evaluate the clogging of the insides of the

burners. However, experience with burners of this type indicates that vaporizing type burners are unsatisfactory when used with leaded gasoline.

As the result of a heat utilization study, the following tabulation indicates the heat required to vaporize 1 lb of water introduced into the incinerator at ambient temperatures.

To raise from 76 F to 212 F	136 Btu
To convert from liquid to vapor at 212 F	970 Btu
Total	1106 Btu

The incinerator at Fort Belvoir used 6630 Btu to evaporate 1 lb of water. A 16.6 percent thermal efficiency, as follows, is indicated.

$$\frac{(1106 \text{ Btu})\ (100)}{(6630 \text{ Btu})} = 16.6 \text{ percent}$$

The efficiency of the unit in polar regions would be even lower because of the frozen nature of the water. The following heat requirement is stipulated to vaporize 1 lb of ice introduced into the incinerator at -40 F.

To raise from -40 F to 32 F	58 Btu
To convert from solid to liquid at 32 F	144 Btu
To raise liquid from 32 F to 212 F	180 Btu
To convert from liquid to vapor at 212 F	970 Btu
Total	1352 Btu

Thus, the heat requirement for converting 1 lb of ice into steam is increased 22 percent over that for temperate zones, as follows:

$$\frac{(1352 \text{ Btu} - 1106 \text{ Btu})\ (100)}{(1106 \text{ Btu})} = 22 \text{ percent}$$

In addition, the heat loss due to radiation and convection would be greatly increased, if the unit was operated outdoors at -40 F instead of 76 F.

The investigators made a search of current regulations and directives concerning the conduct of research and development and field operations involving the disposal of wastes. Minimum performance requirements and acceptable methods are not a matter of record. All references to waste disposal noted were limited to the assignment of responsibility to Command in the field. The Medical Service is assigned responsibility for advising Command on all matters pertaining to health. Medical Service advice to the Corps of Engineers

on waste disposal activities is not a matter of record. No record was found of firm requirements for waste disposal equipment or staff guidance for research and development in this basic field.

IV. CONCLUSIONS AND RECOMMENDATIONS

8. Conclusions. It is concluded that:

a. The prototype portable incinerator for a 22-man barracks unit is capable of reducing human wastes, garbage, and rubbish to a fine ash.

b. The waste-to-fuel ratios averaged 1.49 lb of human waste per pound of fuel, 1.47 lb of garbage per pound of fuel, and 0.37 lb of rubbish per pound of fuel for the EMDL tests.

c. Of the total fuel consumption, 22 percent is used to destroy odors, and 78 percent for incineration proper.

d. Because the water content of human wastes and garbage is very high, the incinerator operates primarily as an evaporator until all water is driven off.

e. The efficiency of the incinerator is further reduced when using combustible materials because of the lack of sufficient air provided to the combustion chamber.

f. Operation demands extreme attention and caution to assure adequate incineration and to avoid injury to the operators.

g. The unit tested does not provide an economical method of waste disposal and there is no basis for believing that modification of the item would materially improve its performance.

h. For the application under consideration in this study, incineration is not an acceptable method of disposal of human wastes and garbage, and only improvised facilities are required for burning combustible rubbish.

i. Requirements and acceptable methods for field waste disposal, promulgated by competent authority, are not a matter of record.

9. Recommendations. It is recommended that:

a. The prototype portable incinerator for a 22-man barracks unit, developed under Project 8-71-04-003 and described herein, not be considered for use in the disposal of wastes, garbage, or rubbish in the field.

b. Action be initiated to review and study the entire subject of field waste disposal to provide administrative and technical guidance to further work in this basic field.

APPENDICES

APPENDIX A

AUTHORITY

SECURITY CLASSIFICATION UNCLASSIFIED

RESEARCH AND DEVELOPMENT PROJECT CARD | 2. SEC. U | 3. PROJ. NO. 8-71-04-003
4. CETC 1881/216
5. REPORT DATE 2 Nov. 50

1. PROJECT TITLE: UTILITIES, PACKAGED FOR PREFABRICATED BUILDINGS

6. BASIC FIELD OR SUBJECT: Structures

7. SUB FIELD OR SUBJECT SUB GROUP: Housing — T.O. 80-9

8. COGNIZANT AGENCY: Corps of Engineers

9. DIRECTING AGENCY: Engr. Res. & Dev. Div., MD, OCE

10. REQUESTING AGENCY: Office, Chief of Engineers

11. PARTICIPATION AND/OR COORDINATION:
Department of the Navy (C)
Department of the Air Force (C)
Army Field Forces (C)
All Technical Services (C)

12. CONTRACTOR AND/OR LABORATORY: Engr. Res. & Dev. Laboratories, Fort Belvoir, Virginia

CONTRACT/W. O. NO.

13. RELATED PROJECTS: 8-71-04-001, 8-71-04-002

14. DATE APPROVED: 1 December 1950

15. PRIORITY 2-A | 16.

17. EST. COMPL. DATES: RES. June 1952; DEV. June 1953; TEST June 1954; OP. EVAL. ?

18. FISCAL EST'S: 51 — 45 M; 52 — 133 M; T — 250 M

19.

20. REQUIREMENT AND/OR JUSTIFICATION
There is a requirement for self contained utility packages such as toilet and ablution equipment, hot water and steam generators, incinerators, wiring harnesses, and prefabricated piping kits suitable to multi-purpose application in prefabricated buildings and which are suitable to modular construction. Existing methods are inadequate for modern field operations and require excessive numbers of trained troops for installation.

21. BRIEF OF PROJECT AND OBJECTIVE

a. Brief:

(1) Objective:

(a) This project is expected to develop air transportable packaged utility units of basic module pattern and utility service kits adequate for prefabricated buildings used as troop housing, hospitals, communications centers, repair shops, warehouses, and other specialized purposes requiring utility services for proper functioning; toilet and ablution equipment of unit capacity to adequately serve military personnel occupying prefabricated buildings; hot water and steam generators for use with kitchens, hospitals, prefabricated toilet and ablution rooms and for other special purposes; waste disposal incinerators for the sanitary disposal of garbage, hospital waste, trash, and human wastes to prevent the spread of disease to man and animals and to supply a means for elimination of unsanitary nuisance problems from the dumping of decayable matter; module pattern kitchens with utility service kits suitable for use as troop mess kitchens and hospital diet kitchens utilizing standard military equipment as specified by the Quartermaster Corps; and steam distribution piping, plumbing piping, and other piping service kits to adequately serve the equipment housed in prefabricated buildings, including hospital equipment.

(2) Military Characteristics:

(a) The equipment shall:

1. Be capable of being mounted on, adjacent to, or separate from the prefabricated structures without interference with the purposes of the primary structure.

22.	SUBJECT	PC.	IC & R	L.	L.	C.

JRDB FORM 14, 1 APR 1947 — WDGRD — PAGE 1 OF 3 PAGES

SECURITY CLASSIFICATION UNCLASSIFIED

RESEARCH AND DEVELOPMENT PROJECT CARD (RDPC PROJECT) | b. PROJ. NO. 0 | b. PROJ. NO. 8-71-04-003
UTILITIES, PACKAGED FOR PREFABRICATED BUILDINGS | d. ORGANIZATION: USARIEM CE | e. REPORT CONTROL SYMBOL: CSGRD-50

2. Be of adequate capacity and sufficiently flexible in operation for maximum utilization.
3. Be constructed in the unit package, sectional component method permitting high interchangeability of component items between package types and permitting base shop repair methods by use of replacement components.
4. Be of a design permitting use of simple cycles and processes understandable by maintenance troops with a minimum of training.
5. Be of multi-purpose design such that units of any given type will be applicable to a maximum of purposes for that type package.
6. Be self contained, insofar as practicable, for each type, and reliant only on utility services available in another package type.
7. Be of maximum efficiency commensurate with size and weight limitations imposed by transportability and airborne requirements.
8. Be capable of satisfactory performance at any air temperature from -65° F to +125° F, and while exposed to maximum Solar radiation, and must be capable of safe storage at temperatures from -80° F, for periods of several days at a time, to +160° F for periods of at least 4 hours daily, and in high relative humidity conditions.
9. Be suitable for transportability in Phase IV of airborne operations.
10. Be treated for elimination of interference with radio communications in accordance with applicable Signal Corps Specifications, as regards appropriate components.

b. Approach:
(1) Industry and military agencies will be canvassed to determine if any product exists which can be used or modified to produce a satisfactory end item.
(2) If no item is available, research and development contracts will be awarded to outstanding organizations with specialized engineering and scientific knowledge.
(3) Pilot models, based upon the most suitable design, will be procured and subjected to engineering tests, utilizing the facilities and personnel of NRDL and of the Army Industrial Hygiene Laboratory.
(4) Recommendations will be made for Service Test of items incorporating modifications indicated by engineering tests.
(5) Based on service test results, drawings and specifications suitable for quantity procurement will be prepared, and final report submitted with recommendations regarding classification of equipment action.

c. Subtasks: None.

d. Other Information:
(1) References:
(a) Memorandum from Logistics Division, OCREA, Subject: Assignment

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SECURITY CLASSIFICATION UNCLASSIFIED

RESEARCH AND DEVELOPMENT PROJECT GUIDE (RDPG FORM 6)	2. DOC. 0
3. PROJECT TITLE	
UTILITIES, PACKAGED, FOR PREFABRICATED BUILDINGS	

of Research and Development Cognizance for Prefabricated Shelters, File CSGLD/P1 634, dated 2 Feb. 1949.

(b) Report of the Army Equipment Board (Secret), Ft. Monroe, Virginia, dated 8 March 1950.

(2) Discussion:

(a) It is expected that the equipment developed under this project will be of the packaged, sectional component design of the following functional types:

1. Toilet and ablution equipment.
2. Hot water and steam generators.
3. Incinerators.
4. Kitchen equipment and services.
5. Electric power and lighting wiring harnesses.
6. Steam, hot water, and plumbing piping and other special purpose piping including hospital requirements.

(b) Agencies interested in this project, in addition to the Corps of Engineers, are Department of the Navy, Department of Air Force, Army Field Forces, and all Technical Services.

WORD-

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SECURITY CLASSIFICATION UNCLASSIFIED

APPENDIX B

DATA SHEETS

PROTOTYPE PORTABLE INCINERATOR

Test Run No. 1, 17 Sep 52

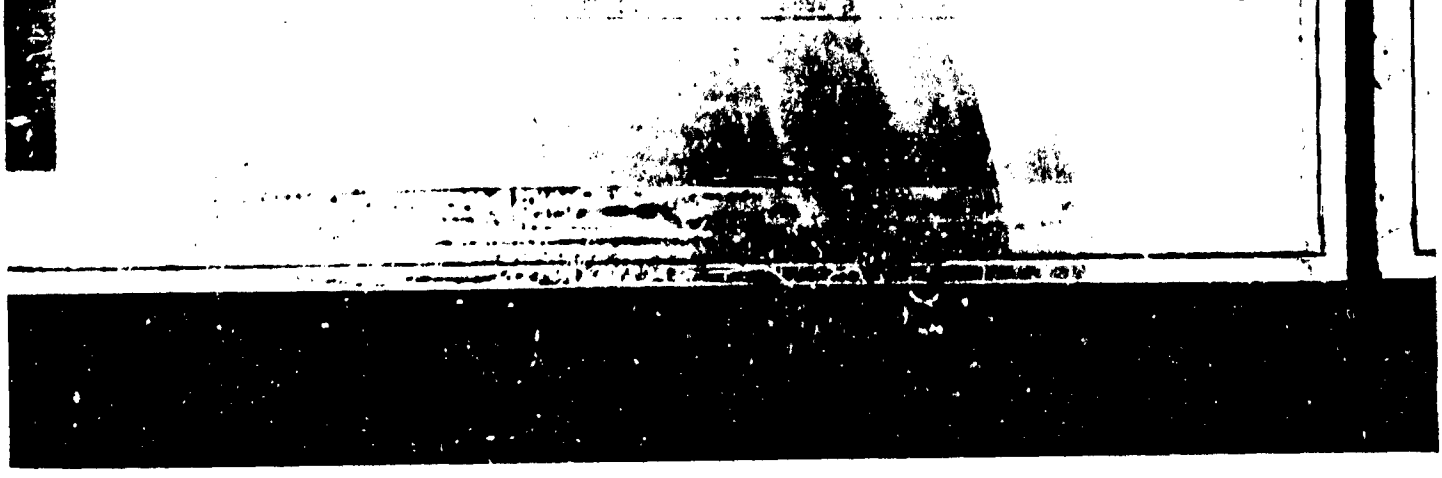
Time of Day	Temp (F) Stack	Temp (F) Top of Pan	Temp (F) Bottom of Pan	Fuel Tank Pressure (psi)	Comments
0935	---	---	---	50	Used two burners.
0940	795	1080	700	50	Air intake ¼ open.
0945	300	1090	700	50	---
0950	940	900	780	50	---
0955	1010	1000	1100	50	Clear, no wind.
1000	1030	1040	1040	50	---
1005	1080	1070	1210	50	---
1010	990	1040	1240	50	---
1015	1100	1110	1260	50	---
1020	1160	1130	1170	50	---
1025	1160	1140	1170	50	---
1030	1170	1150	1190	50	---
1035	1180	1150	1190	50	---
1040	1130	1190	1160	50	---

Operators: [illegible] and Sgt. Kennedy. Atmospheric Conditions: 0930, 73 F; 1040, 80 F. Clear, no wind. Matter Incinerated: 99 lb of water. Weight and Type of Fuel: 3¼ lb of diesel oil. Waste-to-Fuel Ratio. 2.9 lb of material to 1 lb of fuel. Incineration Time: 1 hr and 5 min. Remarks: Microsec automatic potentiometer was used for the temperature readings.

Test Run No. 2, 17 Sep 52

Time of Day	Temp (F) Stack	Top of Pan	Bottom of Pan	Fuel Tank Pressure (psi)	Comments
1315	---	---	---	50	Used both burners.
1320	680	900	1000	50	Air intake ½ open.
1325	[illegible]	780	1100	50	---
1330	700	840	1030	50	---
1335	800	900	1200	50	---
1340	880	850	1320	50	---
1345	680	700	1120	50	---
1350	680	740	1280	60	---
1355	700	870	1330	60	---
1400	630	780	1340	59	---
1405	640	710	1320	60	---
1410	1220	640	640	55	Bottom burner was irregular.
1415	1020	800	460	60	---
1420	1040	540	380	59	Ran out of gasoline.

Operators: Gutierrez and Sgt. Kennedy. Atmospheric Conditions: 1315, 84 F. Clear and sunny. Matter Incinerated: 99 lb of water. Weight and Type of Fuel: 36.75 lb of gasoline. Waste-to-Fuel Ratio: 2.7 lb of material to 1 lb of fuel. Incineration Time: 1 hr and 5 min. Remarks: Sgt. Kennedy burned one hand trying to relight the bottom torch. The solid bottom pan was revealed. Micromax automatic potentiometer was used for the temperature readings.



Test Run No. 3, 18 Sep 52

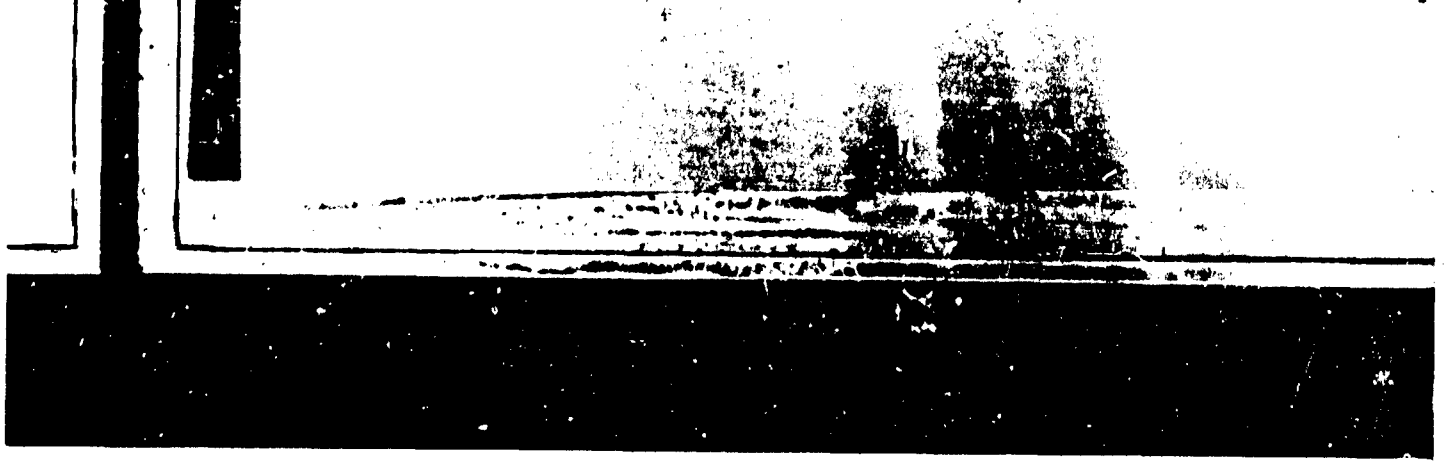
Time of Day	Temp (F) Stack	Top of Pan	Bottom of Pan	Fuel Tank Pressure (psi)	Comments
1415	---	---	---	50	Air intake fully open.
1420	700	740	700	50	Both burners were on.
1425	1200	1140	1280	50	---
1430	1210	1190	1220	50	Stirred the rubbish.
1435	1290	1260	1210	50	---
1440	1310	1460	940	50	---
1445	1390	1410	1020	50	Stirred the rubbish.
1450	1350	1440	980	50	Bottom burner was clogged.
1455	1350	1450	1310	50	---
1500	1310	1420	1280	50	---
1505	1270	1420	1140	50	---
1510	1310	1390	1280	50	Stirred the rubbish.
1515	1340	1420	1330	50	---
1520	1350	1460	1330	50	---
1525	1390	1510	1480	50	---

Operators: Gutierrez and Sgt. Kennedy. Atmospheric Conditions: 1415, 75 F. Cloudy, no wind. Matter Incinerated: 24 lb of rubbish. Weight and Type of Fuel: 55 lb of diesel oil. Waste-to-Fuel Ratio: 0.4 lb of material to 1 lb of fuel. Incineration Time: 1 hr and 10 min. Remarks: The incinerator performed well, but the lack of sufficient air prevented fast combustion.

Test Run No. 4, 19 Sep 52

Time of Day	Temp (F) Stack	Top of Pan	Bottom of Pan	Fuel Tank Pressure (psi)	Comments
1325	---	---	---	50	Raining; two burners.
1330	75	80	80	50	Air intake ½ open.
1335	220	180	190	50	Air intake ½ open.
1340	500	770	540	50	Air intake ½ open.
1345	860	680	480	50	Burners did not burn well.
1350	1110	900	500	50	Raining.
1355	1300	920	520	50	Raining.
1400	910	1060	550	50	Raining.
1405	1180	1080	600	50	Raining.
1410	820	880	620	50	Raining.
1415	940	990	650	50	Stopped raining.
1420	1400	1290	670	50	---
1425	890	1360	700	50	Air intake ½ open.
1430	740	940	800	50	---

Operators: Gutierrez, Sgt. Kennedy, and Cpl. Kennedy. Atmospheric conditions: 69 F. Clear and cool. Matter Incinerated: 39 lb of human waste (feces, urine, and toilet paper). Weight and Type of Fuel: 38.75 lb of diesel oil. Waste-to-Fuel Ratio: 1 lb of material to 1 lb of fuel. Ash content, 1.3 percent. Incineration Time: 1 hr and 5 min. Remarks: No odor was noticed during incineration. Burners did not burn well; first one, then the other, kept going out. No odor was noticed during incineration.



Test Run No. 5, 22 Sep 52

Time of Day	Temp (F) Stack	Temp (F) Top of Pan	Temp (F) Bottom of Pan	Fuel Tank Pressure (psi)	Comments
0950	---	---	---	50	Cloudy, cool, and windy.
0955	750	880	1040	50	Two burners.
1000	820	910	840	50	Stack was smoky.
1005	760	910	360	50	Air intake ½ open.
1010	720	920	860	50	---
1015	760	990	950	50	---
1020	1300	1130	910	50	Required approx. 30 min to burn well.
1025	1360	1190	930	50	---
1030	1400	1290	1040	50	---
1035	1400	1300	1080	50	Raining.
1040	1390	1330	1130	50	Raining.
1045	1380	1320	1120	50	Raining.
1050	1300	1340	1150	50	Raining.
1055	1290	1340	1150	50	Raining.
1100	1190	1310	1190	50	Raining.
1105	1180	1330	1200	50	Raining.
1110	1240	1340	1200	50	Raining. No odor noticed.

Operators: Gutierrez and Cpl. Evasky. Atmospheric Conditions: 66 F. Cloudy, cool and windy. Matter Incinerated: 55 lb of Army mess garbage (liquified). Weight and type of Fuel: 33.5 lb of fuel oil. Waste-to-Fuel Ratio: 1.6 lb of material to 1 lb of fuel. Ash content, 2.38 percent. Incineration Time: 1 hr and 15 min.

Test Run No. 6, 23 Sep 52

Time of Day	Temp (F) Stack	Top of Pan	Bottom of Pan	Fuel Tank Pressure (psi)	Comments
1325	---	---	---	50	Two burners were operating.
1330	1010	770	700	50	Watched for gas vapor.
1335	730	850	940	50	Air intake ½ half open.
1340	840	930	1030	50	---
1345	1050	1140	1140	50	Excellent incineration.
1350	1280	1230	1190	50	---
1355	1260	1290	1210	50	---
1400	1350	1400	1210	50	Cut down top burner.
1405	1370	1350	1200	50	---
1410	1340	1350	1230	50	---
1415	1070	1170	1160	50	Top burner out.
1420	700	1010	1240	50	---
1425	1010	1100	1240	50	---
1430	1030	1090	1240	50	---
1435	910	1030	1240	50	---
1440	960	1030	1220	50	---
1445	850	960	1190	50	---
1450	1180	1190	1400	50	---
1455	1190	1350	1410	50	---
1500	1250	1450	1490	50	---
1505	1280	1470	1530	50	---
1510	900	1470	1580	50	---
1515	1280	1480	1590	50	---
1520	1300	1480	1580	50	---
1525	1160	1400	1600	50	---
1530	1130	1460	1600	50	---
1535	---	---	---	---	---

Operator: Gutierrez. Atmospheric Conditions: 84 F. Sunny and warm. Matter incinerated: 87.0 lb of Army mess garbage (heavy in solids). Weight and Type of Fuel: 64.5 of gasoline. Waste-to-Fuel Ratio: 1.35 lb of material to 1 lb of fuel. Ash content, 8.1 percent. Incineration Time: 2 hr and 10 min.

Test Run No. 7, 24 Sep 52

Time of Day	Temp (F) Stack	Top of Pan	Bottom of Pan	Fuel Tank Pressure (psi)	Comments
0930	---	---	---	50	Both burners on.
0935	1240	1300	1380	50	---
0940	1620	2000	1990	50	Potentiometer was unbalanced.
0945	1990	2000	2000	50	Air intake was fully open.
0950	2000	2000	2000	50	Bottom air intake was fully open throughout the test.
0955	1990	2000	2000	50	---
1000	2000	2000	2000	50	Stirred the rubbish.
1005	1980	2000	1930	50	---
1010	2000	2000	1560	50	Cut off top burner to look at top pan.
1015	1500	1520	1540	50	---
1020	1440	1520	1560	50	Stirred the rubbish.
1025	1440	1520	1600	50	---
1030	1450	1540	1640	50	---
1035	1460	1570	1670	50	Cut off top burner to look at top pan.
1040	1420	1530	1640	50	---
1045	1480	1560	1680	50	---
1047	1480	1570	1700	50	---

Operators: Gutierrez, Sgt. Kennedy, and Cpl. Knucky. Atmospheric Conditions: 64 F in the a.m. Cloudy and cool. Matter Incinerated: 22.5 lb of rubbish. Weight and Type of Fuel: 66.5 lb of gasoline. Waste-to-Fuel Ratio: 0.34 lb of material to 1 lb of fuel. Ash content, 6.6 percent. Rate of Incineration: 17.5 lb per hr. Incineration Time: 1 hr and 17 min. Remarks: The incinerator performed well, but again it was found that it takes too much fuel to incinerate rubbish.

Test Run No. 8, 25 Sep 52

Time of Day	Temp (F) Stack	Temp (F) Top of Pan	Temp (F) Bottom of Pan	Fuel Tank Pressure (psi)	Comments
0945	---	---	---	50	Two burners were operating.
0950	809	868	1037	50	Baffles were used.
0955	851	879	952	50	Front failed to stay closed.
1000	868	868	1224	50	Slight odor was noticed 100 ft from the incinerator.
1005	868	876	1362	50	---
1010	916	891	1382	50	Air intake ½ open.
1015	935	831	1146	50	No foaming.
[illegible]	1161	1008	1385	50	---
1025	1296	1100	1440	50	---
1030	1312	1163	1443	50	---
1035	1280	1202	1449	50	---
1040	1338	1257	1477	50	---
1045	1366	1276	1543	50	---
1050	1348	1295	1570	50	---
1055	1304	1300	1570	50	---
1100	1370	1336	1534	50	---
1105	1412	1332	1534	50	---
1110	1367	1351	1574	50	---
1115	1291	1408	1628	50	---
1120	1142	1364	1570	50	---
1125	1130	1412	1596	50	---

Operators: Gutierrez, Sgt. Kennedy, and Cpl. Krusky. Atmospheric Conditions: 0945, 70.5 F. Clear and sunny. Matter Incinerated: 95 lb of raw sludge (from plain sedimentation tanks). Weight and Type of Fuel: 73 lb of gasoline. Waste-to-Fuel Ratio: 1.30 lb of material to 1 lb of fuel. Ash content, 2.1 percent. Incineration Time: 1 hr and 40 min. Remarks: Temperatures were read with a volt meter and the readings were converted to Fahrenheit. Sludge in the front part of the pan burned faster than in the back.

Test Run No. 9, 1 Oct 52

Time of Day	Temp (F) Stack	Temp (F) Top of Pan	Temp (F) Bottom of Pan	Fuel Tank Pressure (psi)	Comments
1300	---	---	---	50	Two burners were operating.
1305	100	400	300	50	Black smoke out of stack.
1310	700	980	1120	50	Top air intake was open; bottom air intake was open.
1315	790	1000	1180	50	Stack no longer smoky.
1320	800	1060	1140	50	No odor was noticed.
1325	800	1060	1140	50	There was no foaming.
1330	800	1080	1300	50	No odor.
1335	810	1060	1200	50	No foaming.
1340	800	1040	1210	50	Odor noticed 100 ft away.
1345	800	1060	1080	50	Bottom burner was irregular.
1350	800	1030	1100	50	Odor noticed in the distance.
1355	880	1130	1430	52	No foaming.
1400	890	1140	1380	51	Peculiar odor, but not offensive.
1405	1000	1150	1200	51	No foaming. Bottom burner was irregular.
1410	990	1120	1300	51	Bottom burner now normal.
1415	1020	1140	1390	50	Bottom burner now normal.
1420	1050	1160	1420	50	Bottom burner now normal.
1425	1050	1170	1480	50	No odor was noticed.
1430	1050	1170	1400	50	Removed front section of baffle.
1435	1010	1130	1460	50	Raw matter and liquid.
1440	1040	1150	1430	50	Raw matter and liquid.
1445	990	1130	1460	50	Liquid in the pan, raw matter.
1450	1000	1110	1450	50	No liquid; raw matter.
1455	1010	1120	1430	50	Raw matter in pan.
1500	930	1100	1410	50	No odor.
1505	970	1100	1410	50	No odor.
1510	970	1100	1420	50	No odor.
1515	990	1100	1410	50	No odor.
1520	970	1120	1420	50	Unburned materials were found.
1525	990	1100	1420	50	---
1530	980	1110	1400	50	Unburned matter was found.
1535	970	1080	1400	50	---
1540	970	1130	1380	50	Unburned matter was found.
1545	970	1150	1380	50	---
1550	950	1130	1400	50	Rags were burning.
1555	950	1130	1420	50	Incinerator warping.
1600	980	1120	1400	50	Difficult to pan out after incineration.
1605	900	1170	1440	50	---
1610	900	1080	1450	50	Completed incineration.

Operators: Gutierrez, Sgt. Kennedy, Pfc. Johrling, and Pfc. Mathews. Atmospheric Conditions: 88 F. Clear. Matter Incinerated: 100 lb of latrine human waste (privy) Weight and Type of Fuel: 46 lb of diesel oil. Waste-to-Fuel Ratio: 2.18 lb of material to 1 lb of fuel. Ash content, 2.5 percent. Incineration Time: 3 hr and 10 min. Remarks: Filler mesh of burners was too large. The door was fixed so that it would stay closed. The pan was fixed so that it would not slide out. The position of the thermocouples was changed so as not to interfere with the baffles; the baffles were on and off.